

II. Hypersociability in Williams Syndrome

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Abstract

■ Studies of abnormal populations provide a rare opportunity for examining relationships between cognition, genotype and brain neurobiology, permitting comparisons across these different levels of analysis. In our studies, we investigate individuals with a rare, genetically based disorder called Williams syndrome (WMS) to draw links among these levels. A critical component of such a cross-domain undertaking is the clear delineation of the phenotype of the disorder in question. Of special interest in this paper is a relatively unexplored unusual social phenotype in WMS that includes an overfriendly and engaging personality. Four studies measuring distinct

aspects of hypersocial behavior in WMS are presented, each probing specific aspects in WMS infants, toddlers, school age children, and adults. The abnormal profile of excessively social behavior represents an important component of the phenotype that may distinguish WMS from other developmental disorders. Furthermore, the studies show that the profile is observed across a wide range of ages, and emerges consistently across multiple experimental paradigms. These studies of hypersocial behavior in WMS promise to provide the groundwork for crossdisciplinary analyses of gene–brain–behavior relationships. ■

INTRODUCTION

One of the great challenges in understanding the genetic and brain bases of behaviors is to link studies across different levels of investigation. Studies of syndromes that involve atypical cognition, brain organization, and molecular genetic structure provide an opportunity to link such domains. There has been considerable progress in cross-domain studies in the neurosciences, especially in the cognitive neurosciences, over the past decade using Williams syndrome (WMS) as a model (Bellugi, Lichtenberger, Mills, Galaburda, & Korenberg, 1999b; Bellugi, Mills, Jernigan, Hickok, & Galaburda, 1999c; and papers in this volume). Advances in techniques across disciplines have improved cross-domain research, leading to a better understanding of the neural bases of mental capacities, such as language, spatial abilities, face processing, and human social behavior.

The aim of the current set of studies is to investigate the neural and genetic bases of social behavior in WMS, a genetic disorder of particular interest due to pronounced abnormalities in the social domain. The paper integrates information from several sources to define a social phenotype for WMS. Individuals with WMS are contrasted with individuals who have other genetically based syndromes, such as Down syndrome (DNS) and Autism, as well as with normal control subjects, to understand which particular aspects of abnormal social behavior are specific to WMS, and to examine the relationships between social behavior and other aspects of cognition in WMS. The findings suggest that a strong drive toward social interaction makes up an important and distinctive part of the WMS behavioral phenotype. In addition, we suggest that the specification of a social profile in WMS may provide the means for cross-level analyses of the

neuroanatomical, neurophysiological and genetic bases of the disorder.

What is Williams Syndrome?

WMS is a rare, genetically based disorder caused by the absence of one copy of approximately 20 genes on chromosome 7, including the genes for elastin, syntaxin 1A, Frizzled, and Lim1kinase, among others (Korenberg et al, this volume; Korenberg et al., 1996; Ewart et al., 1993). The genetic deletion typically results in mild to moderate mental retardation evidenced from standardized tests of intelligence, but a fractionated cognitive profile. Indeed, WMS individuals have poor spatial skills, but are relatively good at certain other cognitive abilities, including language production and the processing of faces (Bellugi et al, this volume; Jones, Hickok, Rossen, & Bellugi, 1999a; Mervis, Morris, Bertrand, & Robinson, 1999; Rossen, Klima, Bellugi, Bihle, & Jones, 1996). The dissociations seen in the WMS cognitive profile are of particular interest to researchers because they offer an opportunity to identify subcomponents that are dissociable in cognition. In most studies of WMS, individuals with WMS are matched to those with other syndromes (e.g., DNS and Autism) on age and/or IQ; the differences between WMS and other disorders are then examined using probes that are domain-specific (see Bellugi et al., in this volume).

Why Studies of WMS Contribute to Understanding Sociability

Results from several studies suggest that there is also a characteristic personality and social nature in WMS individuals, although the facets of this personality profile are still being defined. Studies show that people with WMS display extensive anxiety and have behavioral problems, as do individuals with other disorders that result in mental retardation (VanLieshout, DeMeyer, Curfs, & Fryns, 1998; Einfeld, Tonge, & Florio, 1997). However, there has been a growing body of evidence (from clinical and laboratory studies, parental report, and from our own observations of several hundred subjects) that WMS individuals may be unusually sociable, friendly, and empathic (see reports in this article and Tager-Flusberg, Sullivan, Boshart, Guttman, & Levine, 1996). For instance, in circumstances typically eliciting social reservation (e.g., encountering strangers), infants, toddlers, children, and adults with WMS frequently come directly up to and begin engaging strangers. Parents report attempts to train their WMS child (e.g., adolescent daughter) *not* to talk to strangers—to no avail. The parent may then watch in private horror as their WMS daughter walks up to a complete stranger in a public place, looks him right in the eye and then asks in a friendly and engaging manner, “Are you a stranger?” Other WMS children and adults in our experience an-

nounce that there is no such thing as a stranger; they say (and behave as if) everyone in the world is their friend. Quantifiable measurement in this domain of unrestrained social behavior toward strangers can make a contribution to understanding the unusual phenotype of WMS. Moreover, these studies are relevant to ongoing and future cross-domain research examining “hyper-sociability” relative to the anatomical and genetic bases of the disorder.

Background to Studies

The results reported in this paper are part of a coordinated program aimed at characterizing the cognitive, social and genetic profile of WMS. The paper is divided into four sections, each section containing one or more studies. Section I examines the intersection between social expression and language in WMS. It uses results from narrative, storytelling and biographical interview tasks to investigate clues to the WMS social profile through language, examining the intersection of affect and language. This represents the work carried out by J. Reilly, U. Bellugi, M. Losh, and E. Klima. Section II explores the origins of sociability and affect in infants and toddlers with WMS. Studies in this section make use of an experimental paradigm to measure emotional expression in structured situations, such as parental separation. These studies were carried out by W. Jones and J. Reilly. In Section III, the issue of indiscriminate sociability and overfriendliness (i.e., the overwhelming predilection to seek out and engage in conversation with strangers) in adolescents and adults is examined, using an experimental task designed to measure approachability and interest in unfamiliar people. This section represents studies carried out by U. Bellugi, R. Adolphs, and associates. Section IV investigates parental report of social behavior in three contrasting groups: WMS, DNS, and Autistic subjects. It brings out the contrasts between the withdrawn asocial behavior of autistic individuals and the hypersociability of WMS individuals. This section represents studies carried out by U. Bellugi, A. Lincoln, Z. Lai, M. Chiles, and W. Jones. Taken together, the series of studies reported in the paper highlight, for the first time, the hypersociability of individuals with WMS as an important and quantifiable aspect of the WMS behavioral phenotype.

Subject Selection for Studies

The WMS participants in the studies reported were required to have been diagnosed by a medical geneticist or dysmorphologist familiar with WMS. In addition, each subject met criteria for the syndrome according to the WMS Diagnostic Scoresheet developed by the Williams Syndrome Medical Advisory Board (see also for clinical definitions Morris, Demsey, Leonard, Dilts, & Blackburn, 1988; Preus, 1984). The diagnosis of WMS was geneti-

with WMS and an adolescent with DNS when asked to describe a complex picture. The WMS narrative is longer and more linguistically complex than the DNS narrative and, importantly for this section, contains numerous instances of exaggerated affective expression (e.g., “Poor boy, he could get hurt and break his arm. Poor boy, oh poor thing.”).

An initial study on a small group of WMS adolescents followed up on this observation using a storytelling task (Reilly et al., 1990). Participants were asked to construct a narrative on the basis of a series of pictures from a storybook. The narratives were coded for the storyteller’s use of lexical evaluative devices including: (a) social devices, such as character speech, sound effects, and affective states; (b) cognitive devices, such as inferences, causal connectors, mental states; and (c) vocal prosody, such as the use of vocal pitch changes, vocal lengthening, and changes in vocal volume. See Bamberg and Reilly (1996) for additional methods used in analyzing narratives in developmental populations.

Results from the first narrative study showed that adolescents and adults with WMS constructed coherent and complex stories that made use of high levels of lexical evaluative devices and vocal prosody (see Figure 2). Stories from the WMS subjects were characterized by the abundant use of evaluative devices that served to enrich the referential content of the stories. For instance, subjects with WMS frequently modified their voices to enhance aspects of the story (affective prosody), and made frequent lexically encoded inferences about the mental states of the characters they were

describing (cognitive evaluation). The WMS stories also included numerous utterances whose sole purpose was to engage the listener. In fact, a new category of measurement called “audience hookers” (a type of social evaluation) was developed for this study because there were frequent instances in which such social evaluative devices were used in WMS stories. For instance, WMS narratives frequently included statements like: “...Guess what happened next?,” “What do you know?,” and “Lo and behold, the frog was gone!” In contrast, DNS narratives were very short and were grammatically impoverished. Moreover, stories from both the DNS and the normally developing children showed little or no evidence of the very high degree of expressiveness both in prosody and in lexical “evaluative” devices evident in the WMS narratives. Figure 2 shows the increased affective expression in WMS quantitatively; including linguistically encoded affect and evaluation (a) and exaggerated vocal affective prosody (b). The findings are shown qualitatively as well in Figure 3. The contrast in expressivity between the WMS, the DNS, and the normally developing groups provided the first systematic examination of the hypersocial domain in people with WMS.

Social Expression in Story Narratives during Childhood (5–10 years)

The results from the Reilly et al. (1990) study were intriguing, but were limited by small sample sizes, and examined only adolescents with WMS. We initiated a

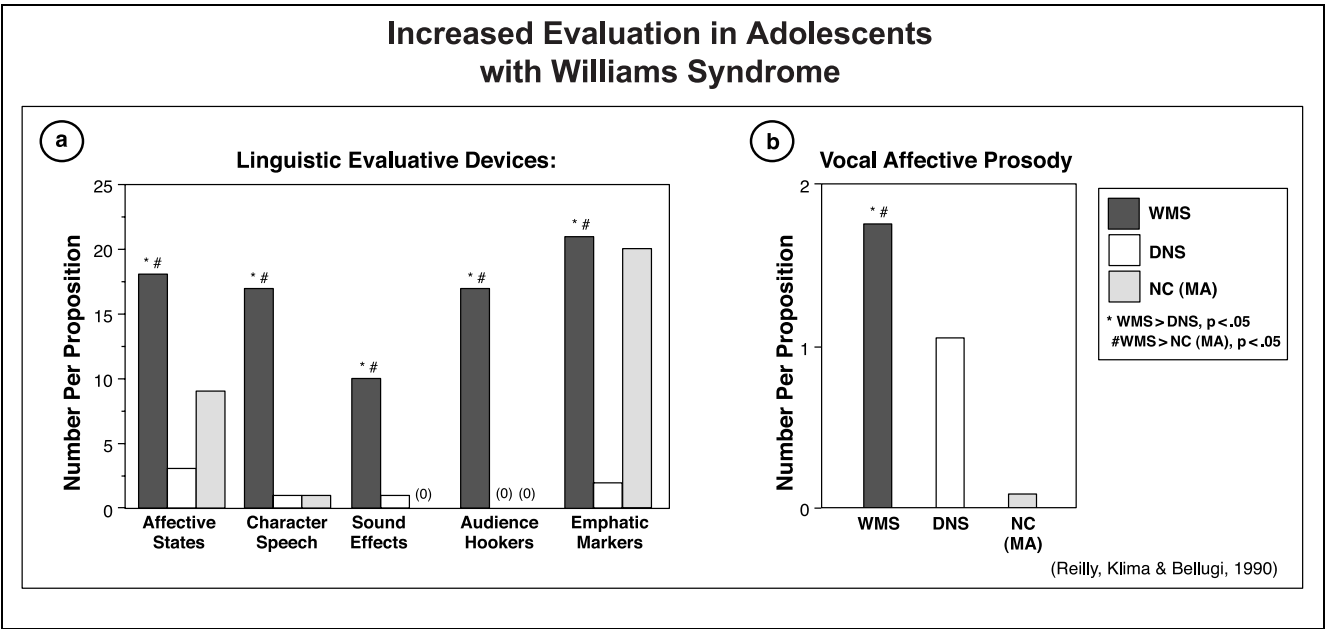


Figure 2. (a) Quantitative analyses reveal that individuals with WMS use significantly more linguistic evaluative devices to enhance their narratives than same-age subjects with DNS or mental age-matched normal controls during the Frog Story task. (b) Vocal affective prosody. Analyses also reveal that vocal affective prosody, such as the use of vocal pitch changes, vocal lengthening, and changes in vocal volume, is used significantly more by WMS than their contrast groups. WMS = Williams Syndrome subjects; DNS = Down Syndrome subjects; NC (MA) = mental age matched normal controls.

Qualitative Examples of Increased Linguistic Evaluation in Adolescents with Williams Syndrome



(M. Mayer, "Frog Where are You")

WMS age 13

And he was looking for the frog. What do you know? The frog family! Two lovers. And they were looking. And then he was happy 'cause they had a big family. And said "good bye" and so did the frog. "Ribbit."

WMS age 17

Suddenly when they found the frogs... There was a whole family of frogs... And ah he was amazed! He looked... and he said "Wow, look at these... a female and a male frog and also lots of baby frogs". Then he take one of the little frogs home. So when the frog grow up, it will be his frog... The boy said "Good bye, Mrs. Frog... good bye many frogs. I might see you again if I come arounmd again". "Thank you Mr. Frog and Mrs. Frog for letting me have one of your baby frogs to remember him".

DNS age 13

There you are. Little frog. There another little frog. They in that... water thing. That's it. Frog right there.

DNS age 18

Thy're hiding; see the frogs... the baby frogs. Uh, the boy, and, and the dog saw the frogs. The frog's got babies. The boy saw the... no, the boy say good bye.

(Reilly, Klima & Bellugi, 1990)

Figure 3. Qualitative examples from narratives of the "Frog, Where Are You?" story show the excessive use of narrative evaluative devices in adolescents with WMS.

second study with a large sample of school-aged children 5–10 years old as a follow up to the original narrative study of adolescents (Bellugi, Losh, Reilly, & Anderson, 1998; Losh, Reilly, Bellugi, Cassady, & Klima, 1997; Jones, Bellugi, Harrison, Rossen, & Klima, 1995). The results from this study of developing WMS children are presented here. Using a narrative task, the performance of young school-aged children with WMS was compared to that of age- and gender-matched normal controls.

Subjects. The Frog Story task was administered to 30 children with WMS (mean age 7.8 years; range 5–10 years) and 30 age- and gender-matched normal control children (mean age 7.8 years; range 5–10 years).

Procedures. The study involved the wordless picture book called "Frog, Where Are You?" (Mayer, 1969), a book that describes a boy and his dog looking for their lost frog. Subjects were asked to produce a narrative on the basis of pictures from the book. Narratives were video-recorded and transcribed by trained coders using the MinCHAT program (MacWhinney, 1995). Each transcript was coded for the number of clauses, morphosyntactic errors, sentence complexity, uses of vocal prosody, and the use of evaluative devices. Indices of vocal prosody included the use of vocal lengthening (saying, "Oh, Mr. Froooooooooog"). Evaluative devices included exclamatory phrases that functioned to renew and maintain audience attention,

character speech, or sound effects. These were frequently accompanied by exclamatory vocal prosody (and seemed to serve to hold the audience's attention), devices that we have termed social engagement devices or audience hooks. Examples from stories of WMS abound: "*Lo and behold!* He knew why his frog had run away. It was time for him to have children..." "Suddenly he woke up." Also noted were the following evaluative devices: 1) The subject inferred the emotional state of a story character ("He was *sad* because the frog left"); 2) Emphatic markers to dramatize the story ("He was *really* sad"); and 3) Inferences of character motivation, causality or mental states ("He *thinks* the frog might be under the log"). We termed the latter *cognitive interferences*.

Because subjects told stories of varying lengths, each index was calculated as a ratio of the total number of propositions used. For instance, the number of times a child used vowel lengthening in their story was divided by the number of proposition (defined as a phrase including a verb and its complements). Data were analyzed with analysis of variance, using group as a factor and with specific measures (e.g., number of propositions, number of exclamatory phrases, etc.) used as dependent variables.

Results. The children with WMS made significantly more morphological errors than their normal controls (ANOVA with proportion of errors by group: $F(2,57) = 21.9$, $p < .05$). These error findings were not surprising,

considering the language and cognitive delays seen in early development in WMS. However, like their adolescent counterparts, young children with WMS made extensive use of evaluative devices to elaborate their stories (ANOVA with total linguistic evaluative devices by group: $F(2,57) = 22.9, p < .05$); (see Figure 4a). When we look internally at the distribution of the different types of evaluation employed (e.g., social vs. cognitive evaluations, as in Figure 4b), the young WMS children also greatly exceeded normal controls in their use of social engagement devices (ANOVA with social engagement devices by group: $F(2,57) = 27.8, p < .05$). Conversely, controls used a higher proportion of inferences of characters' cognitive states or motivations (ANOVA with all cognitive evaluation devices by group: $F(2,57) = 24.8, p < .05$). When these effects were examined by age, the children with WMS used more social evaluative devices across all age groups (all comparisons significant at $p < .05$), and used fewer cognitive evaluative devices than the normal controls (all comparisons significant at $p < .05$).

Discussion. As we might predict from the studies on early language development in WMS children, this group of young children made more errors than their normally developing peers. In great contrast, the WMS stories were consistently high in the total instances of evaluative devices (including intensifiers, character motivation and affective states, and the use of phrases and exclamations to capture audience attention). Despite their late lan-

guage acquisition and frequent grammatical errors in their stories, even the youngest children with WMS used linguistically encoded evaluation more than normal controls. In addition to these group differences showing the high frequency of use of evaluation in WMS, we note that in absolute terms, every individual WMS child in our group exhibited a profile of higher use of evaluative devices than their normal counterparts. This consistency in the high use of evaluation (i.e., lack of variability) stands in stark contrast to the use of evaluation in normally developing children as well as to WMS subjects' performance on structural measures of language. While normally developing children use evaluation for more cognitively based inferences, the WMS children, beginning at an early age, used evaluative devices to engage and maintain their listeners' attention. Taken together, these results demonstrate that from the outset WMS children exploit their developing language abilities for social purposes.

Social Expression in a Biographical Interview Task

WMS children and adolescents exploit the potential of narratives by using high levels of affective prosody and lexically encoded evaluative devices in structured storytelling situations as shown above. The question arises as to the generalizability of these findings to other discourse situations. To complement the narrative data, the spontaneous social use of language was examined during a Biographical Interview task admi-

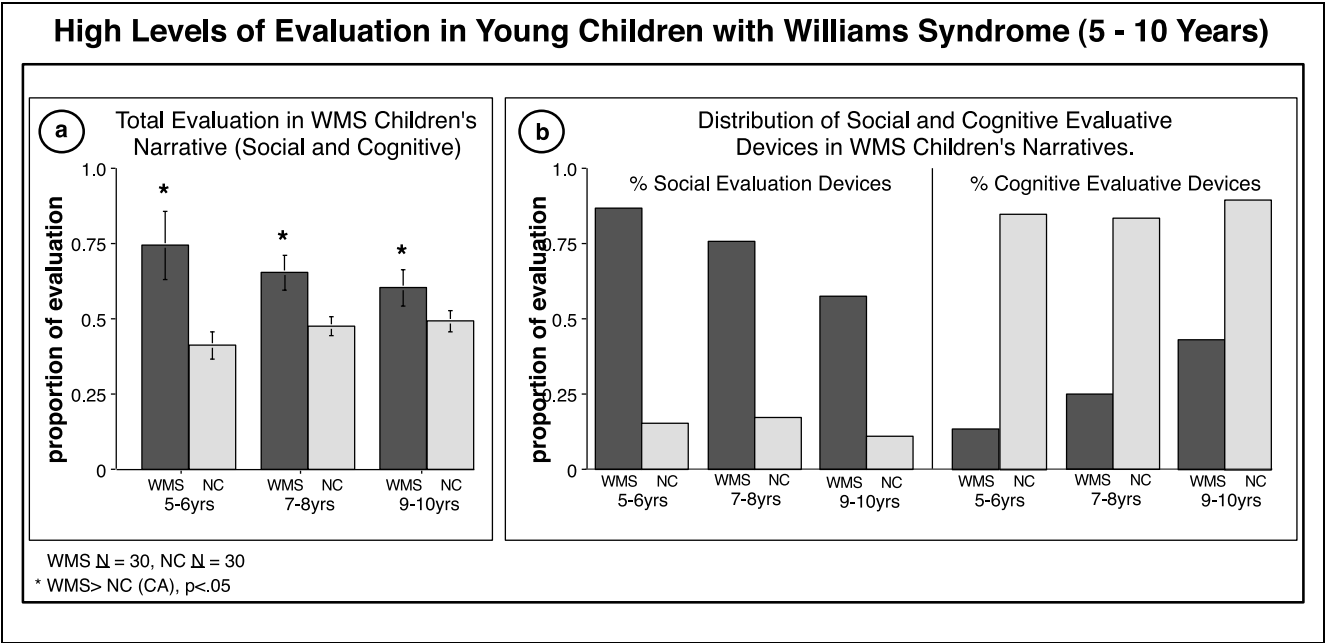


Figure 4. (a) Total evaluation in WMS children's narrative (social and cognitive). Young children with WMS make many more morphosyntactic errors in narratives and, yet, consistently use abnormally high levels of linguistic evaluation in their Frog Story narratives when compared to same-age normal controls. (b) Abnormally, high use of Social Evaluative Devices in WMS children's narratives. WMS children (5–10) make excessive use of socially engaging comments at the expense of using cognitive devices at every age level. They show strong predilection for using social evaluation in their stories, reflecting their hypersociability in language from an early age. NC = normal controls; WMS = Williams Syndrome subjects.

nistered as a warm-up task during the first meeting with an experimental subject (Harrison, Reilly, & Klima, 1995; Reilly, Harrison, & Klima, 1995). Data from age-matched adolescents and adults with WMS and DNS were compared to data from normal control individuals matched for approximate developmental age. Subjects were questioned about their interests and activities (pets, siblings, favorite events) in conversational format.

Subjects. Ten adolescents and adults with WMS and ten with DNS were included in the Biographical Interview study, and were compared to eight normal control subjects matched for approximate developmental age as assessed in previous studies (mean age WMS = 15.8 years, mean age DNS = 15.1 years, mean age controls = 6.5 years).

Procedures. An experimenter conducted a semistructured interview that involved asking each subject questions about his or her family, activities, and interests. Follow-up questions were asked as consistent with natural conversational flow. The interviews were videotaped and transcribed, and the transcripts were coded for the same evaluative devices examined in the narrative studies above. As with the story narrative study, interview indices were normalized for number of propositions. ANOVA techniques were utilized for examining the data.

Results. ANOVA with group as a factor showed that adolescents with WMS, DNS and their developmental age-matched controls answered the same number of interview questions ($F(2,25) = .47$, n.s.), and generated equivalent numbers of propositions in response to the questions ($F(2,25) = 1.55$, n.s.). However, there were significant group differences in the total number of

lexical evaluative devices used in responses (all devices summed together by experimental group: $F(2,25) = 8.54$, $p = .002$). Post hoc followup comparisons revealed that subjects with WMS used significantly more evaluative devices in their responses than either DNS ($p < .001$) or developmental age-matched normal controls ($p < .01$). In particular, the WMS subjects used more descriptions of affective states, evaluative comments, emphatic markers, and character speech than the DNS or normal control subjects (all differences significant at $p < .05$); (see Figure 5).

Additionally, qualitative differences between the WMS interviews and the interviews from other groups were found. For instance, when asked about incidents and facts from their lives, many WMS individuals "turned the tables" on the examiner and actively sought information from them, as if interviewing the examiner. When asked what types of pets he had at home, one WMS subject said, "I have a dog. Do you have a dog? What kind of dog?" Another one asked, "What's your favorite singer?" and another "How long have you lived in California? Where were you born?" Although the interviewer provided brief responses and attempted to redirect the subject to talk about himself or herself, the WMS subjects sometimes continued to ask questions of the experimenter, perhaps a manifestation of the desire for continued social interaction. Finally, when asked to tell about their favorite event, several WMS individuals said something like: "Being here is the best thing that ever happened to me."

Discussion. The results from this study suggest that subjects with WMS use expressive devices across a number of linguistic settings. They support the previous finding that subjects with WMS use more evaluative devices than other subject groups, and show that this aspect of the social profile extends from the more highly

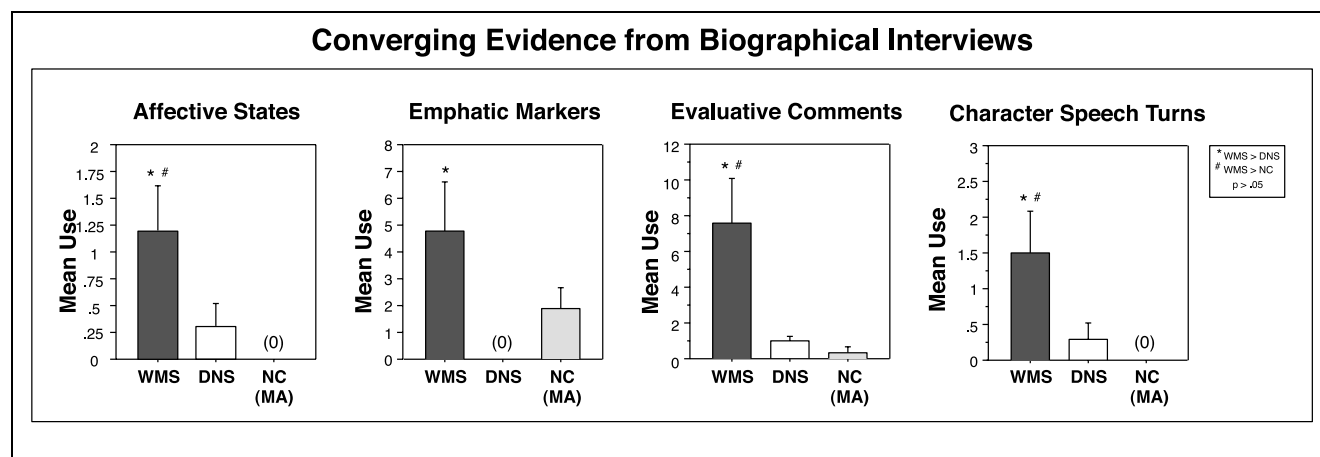


Figure 5. Adolescents and adults with WMS use abnormally high levels of social evaluative devices during an interview task, sometimes turning the tables on the examiner and asking him/her questions, while the same-age subjects with DNS or mental age-matched normal controls use little or no affective expression during the task. WMS = Williams Syndrome subjects; DNS = Down Syndrome subjects; NC (MA) = mental age matched normal controls.

structured narrative to the more conversational context of the interview.

In sum, the results from the studies in Section I demonstrate that subjects with WMS use significantly more evaluative devices than other subject groups, including people with DNS or normal controls. Looking at the function of these evaluative devices, children with WMS used a preponderance of social engagement devices, in contrast to normal control children. The extensive use of social evaluative devices and linguistically encoded affect by WMS subjects is also seen in structured interview tasks as well as in narrative tasks. This is the first empirically driven index of the excessive social and linguistic nature that appears to be a characteristic feature of the WMS phenotype. Taken together, these results demonstrate the pervasiveness of linguistically conveyed hypersociability in WMS.

Section II. Early Development of the Social Nature of WMS

The WMS population is often characterized as unusually social in that subjects exhibit increased interest in engaging others and an apparent ease of engagement in many aspects of the social interaction. For instance, a deaf researcher at The Salk Institute once provided her observation of the differences between WMS and DNS individuals when they come into the lab and up to her desk. Her observation (expressed in sign language) points to the strong drive in children with WMS to engage in social interaction, even in the absence of direct two-way conversation.

The DNS children sometimes come up and touch everything on my desk, so I have to call the experimenter to take them away. The WMS children, in contrast, typically come right up close to me, look me in the face, smile broadly at me, and talk to me even though I sign to them that I can't hear or speak. They seem to be fascinated, continuing to smile and talk to me, all the time looking right into my face while they try to imitate my signs.

This anecdote illustrates the strong attraction to social interaction in children with WMS even when they didn't understand the signed message. The studies presented in Section II focus on very young children with WMS and the emergence of hypersociability.

Until recently, little was known about the early development of sociability in WMS, although this is a behavioral domain of special interest given findings with adolescents and adults with the disorder. Developmentally, the onset of first words and other linguistic and nonlinguistic milestones are significantly delayed in children with the disorder, and it is not until WMS children reach school age that language typically becomes a relative strength (Singer-Harris,

Bellugi, Bates, Jones, & Rossen, 1997). Similarly, significant delays in visuospatial and motor abilities, as well as general cognitive development, are seen in infants and young children (Jones et al., 1999a; Jones, Lai, & Bellugi, 1999b). The observed delays in these aspects of development raises questions of whether the WMS hypersociability appears late, together with the onset of language, or whether it is present prelingually. The early presence of a special hypersocial personality could suggest that this aspect of the WMS phenotype may be independent of other cognitive abilities and is pervasive across development, representing a persistent trait throughout the age span in people with WMS.

Section II presents a study that was designed to measure frequency and intensity of emotional expression as an index for early social behavior (Jones, Anderson, Reilly, & Bellugi, 1998). Using infants and toddlers with WMS (subjects younger than 5 years of age), the study investigates the extent to which the hypersocial nature is present during early development in WMS, or if development in this behavioral domain is delayed similarly to other aspects of cognition. For the study, infants and toddlers with WMS were matched to normal controls matched for developmental or chronological age. Children were administered a subset of the Laboratory Temperament Assessment Battery (LabTab), a battery that was developed to assess positive and negative emotional expression in young children (Goldsmith & Rothbart, 1991, 1992).

Subjects. Twenty-two WMS children aged 15 to 58 months were matched on developmental age and gender to 22 normal controls (mean age WMS = 18.5 months; mean age controls = 18.2 months). In addition, 14 WMS children aged 15 to 31 months were matched on chronological age and gender to 14 normal controls (mean age WMS = 24.6 months; mean age controls = 22.2 months). Results from *t* tests revealed that the groups were well matched for developmental or chronological age (all tests n.s. at $p = .05$).

Procedures. The Parental Separation task from the LabTab (Goldsmith & Rothbart, 1991, 1992) was used as an index of emotional expression. The LabTab is a structured series of tasks developed to elicit specific emotional responses in young children. The Parental Separation task was designed to elicit anger, frustration, and then happiness, and began with the child and parent playing quietly on the floor with specific toys. After 3 to 5 min of free play, the parent was instructed to say "goodbye" to the child and then to leave the room. The child was left alone in the room and was watched closely from behind a one-way mirror. After 30–60 sec the child was reunited with the parent. Affective responses on the face, through the voice, and on the body were coded according to LabTab criteria (Gold-

smith & Rothbart, 1992). Frequency and intensity of each behavior was recorded.

Positive and negative facial expressions were coded during the separation period, and included the presence of either sad, angry, or happy expressions on the face. Vocal behaviors were coded as well, and included crying, whining, whimpering, screaming, cooing, or cheering. Frequencies of each of these affective expressions during the separation period were recorded. Intensity of each expression was tallied on a four-point scale as well, with 0 representing no identifiable expression, and three representing an obvious affective appearance (for instance, an angry facial expression across the eyes, mouth and cheeks). Data were analyzed with repeated measures ANOVA, using group (WMS, normal controls) by condition (face, voice, physical). Positive and negative expressions were examined separately. Comparisons between the WMS subjects and their chronological age-matched controls were conducted separately from comparisons to the developmental age-matched controls, and the frequency and intensity of each condition were analyzed independently as well.

The Bayley Scales of Infant Development (Bayley, 1969) or the Bayley Scales of Infant Development Second Edition (Bayley, 1993) were administered to all children with WMS as an assessment of developmental age (three WMS children were assessed using the original Bayley prior to the release of the second edition). Developmental ages for WMS children above 42 months were calculated using norms for the oldest age group described in the Bayley (1993) manual (42 months). No

child with WMS performed at the ceiling or the floor of the Bayley scales, suggesting that the measure adequately measured the cognitive abilities of the children in the study. Cognitive functioning of the control children was assumed to be within normal limits since the children had met criteria for inclusion into the studies as described above.

Results. During the Parental Separation task in which the child and their parent were purposefully separated, children with WMS expressed less frequent negative facial expressions than chronological age-matched normal controls (repeated measures ANOVA with group by frequency of expression; $F(1,26) = 3.65$, $p < .05$). Moreover, subjects with WMS expressed lower intensity of vocal ($F(1,26) = 5.96$, $p < .05$) and facial ($F(1,26) = 6.06$, $p < .05$) distress and negativity than chronological age-matched controls (see Figure 6). These same effects were also found when individuals with WMS were compared to developmental age-matched controls (facial intensity: $F(1,42) = 15.52$, $p < .01$; vocal intensity ($F(1,42) = 11.52$, $p < .01$). Although normal control children in both groups whined, hit objects, or showed clear evidence of frustration during the period of parental separation, the WMS children did so less frequently and less intensely. Instead, the children with WMS played quietly on the floor with their toys, moved toward the door and waited for their parent to return, or explored the room alone with limited negative expression. When reunited with their parents, the WMS children typically

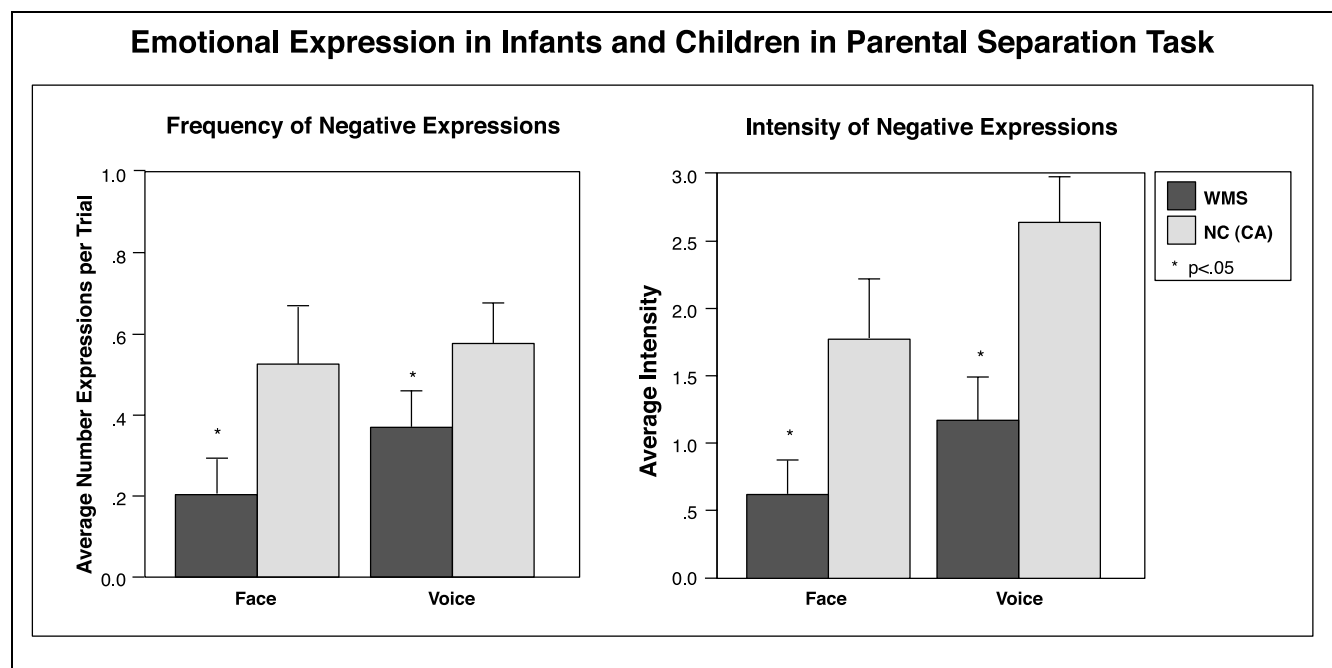


Figure 6. Infants and young children with WMS show more positive (e.g., less frequent and less intense negative) emotional expression than chronological age-matched normal controls during a parental separation task. NC (CA) = normal controls (chronological age); WMS = Williams Syndrome subjects.

re-engaged in play quickly, while the normally developing children frequently needed consoling to continue. In terms of frequency and intensity of positive expression, the children with WMS were the same as control groups on the Parental Separation task ($p < .10$ for all comparisons).


A second important aspect of the early WMS personality appears to include an increased interest in others, as evidenced by the use of positive emotional expressions and/or engaging behaviors directed toward other people. A friendly and overly positive nature was detected during an unstructured warm-up task as well as during standardized cognitive tasks. During the warm-up task, where a child was shown a toy behind a barrier, several WMS children looked excessively at the experimenter's face, often at the expense of performing the task at hand (see Figure 7). While the normal children

were more likely to kick their feet or hit the barrier, the children with WMS tended to engage the examiner using eye contact and by smiling and sometimes cooing (many were prelingual). The WMS children also tended to use alternate behaviors to occupy their interest (e.g., engaging the experimenter, playing with the edge of the table or waving at their parent), rather than becoming upset as normal young children did if they were unable to complete a task.


In addition, during the IQ test administered to assess developmental age, a large number of WMS subjects demonstrated developmentally abnormal social behaviors. For instance, of the seven children tested on a specific block of Bayley items, five demonstrated such concentrated interest in the examiner's face that it appeared to negatively affect their performance on motoric activities. Instead of watching their hands or

Figure 7. A toddler with WMS looks to the experimenter's face at the expense of performing a cognitive task, such as reaching for a toy behind a barrier.


A Young Child Focuses on the Experimenter's Face During Barrier Task




The child ignores toy, looks at the experimenter, beginning of task.



The child's eyes are still looking at the experimenter even when a plexiglass barrier is placed in front of her.



When task is repeated for a second trial, the child again looks up to the experimenter, ignoring the toy.



The child looks at the experimenter, even when the toy is rattled in front of her at the end of the task.

the objects as they put blocks in a cup, the WMS children tended to engage the experimenter through eye contact, and then smile at the examiner as they placed the blocks in the cup. This unusual social behavior toward the examiner sometimes resulted in their failing an item of the task because they were interacting with the experimenter, rather than engaging in the task with objects. Few of the WMS subjects became distressed when the tasks were difficult. Instead of pushing blocks away or dropping items on the floor when they were frustrated, the WMS subjects tended to smile at the examiner, look to their parent, or babble at or engage others in the room.

Discussion. The findings from this study are interpreted as support for the early emergence of a hyper-social profile in WMS. The social behavior of infants with the disorder is characterized by a strong attraction to social interaction that may interfere with their focus on cognitively driven tasks. Such behaviors may be used by infants and toddlers with WMS to deflect from engagement in activities that are difficult for them. Behaviors, such as prolonged eye contact and smiling, appear to be used to socially engage others and, yet, may interfere with their ability to respond with appropriate cognitive solutions. The findings suggest that many aspects of the expressive and social nature of people with WMS are present very early on. Together, the results suggest that children with WMS may have an attraction to social interaction, which is apparent even in infancy.

Section III. Hypersociability Toward Strangers as Characteristic of WMS

The social behaviors of individuals with WMS include an apparent lack of fear of strangers and an overfriendliness with strangers. For instance, one mother reported that her daughter with WMS approached a stranger in a department store and asked what she had in her purse. The woman was so taken with the child that she emptied out her entire purse so that the child could view the items! There are consistent reports from parents stating that their WMS child has an almost “uncontrollable urge” to approach people. Similarly, parents often report that their WMS child has an unusual ability to remember the faces and names of individuals that they meet, even for people that they have met only once, years earlier. Often parents cannot recall all the information the child can. Parent anecdotes consistently describe a WMS personality type that is characterized by fearlessness in social interactions with strangers, an excessive desire for social contact, and an ability to readily connect with strangers and engage them in conversation. Section III describes an experiment that quantifies the increased tendency of WMS individuals to approach and engage in interactions with strangers.

Subjects. Twenty-six subjects with WMS and 26 age- and gender-matched normal controls were included (mean age WMS = 23.6 years, SD = 8.6, 16 female, 10 male; mean age controls = 25.5 years, SD = 7.7, 15 female, 11 male). Results from a *t* test with age and group revealed that the groups were well matched (n.s., $p > .05$). A third group of 12 normally developing children of ages 7–10 years (mean age 8.3 years) was also included in order to provide a group matched approximately to the general cognitive performance of the WMS group; this group is referred to as “mental-age controls.”

Stimuli and Procedures. The task included in the study came from a modified version of a task that has been used previously to assess social judgment in adult populations (Adolphs, Tranel, & Damasio, 1998), the Approachability task. For the purposes of the WMS study, this task was slightly altered and the rating scale modified to better accommodate the behavioral and cognitive needs of the WMS subjects. Subjects were shown black-and-white photographs of unfamiliar adult faces in natural poses. Forty-two stimuli from the original 100 photographs used by Adolphs et al. (1998) were selected (the 21 pictures previously found to be rated most approachable, and the 21 previously found to be rated least approachable by normal adult subjects; cf. Adolphs et al., 1998). Upon seeing each photograph, subjects were asked to rate how much they would like to go up to each person and begin a conversation with them. There was no time limit. Response ratings were given on a five-point color-coded Likert scale, with higher scores denoting a greater desire to approach and talk to the person (see Figure 8). Each response was coded numerically on a scale from -2 to $+2$. Before beginning the task, subjects were familiarized with the rating scale using a sample set of faces.

Results. We divided our analysis into two parts: Data for the 21 faces that normal controls gave the most negative ratings, and data for the 21 faces that normal controls gave the most positive ratings. An examination of the mean ratings given to each block of 21 faces showed that subjects with WMS gave more positive ratings than did normal subjects. For the 21 most negative faces, WMS subjects gave mean ratings of -0.54 (SD = 1.39) while normal controls gave mean ratings of -0.96 (SD = 0.96); and for the 21 most positive faces, WMS gave mean ratings of 1.32 (SD = 1.1) while normal controls gave mean ratings of 0.84 (SD = 1.12).

ANOVA with subject group (WMS, normal control, mental age control) and stimulus valence (in the 21 most positive faces, or in the 21 most negative faces) as factors was performed. There were significant effects of subject group ($F = 10.67$, $p < .0001$), of stimulus valence ($F = 227.18$, $p < .0001$), and of their interaction ($F = 19.04$, $p < .0001$). Scheffe post hoc tests revealed that the two control groups did not differ ($p > .2$), but

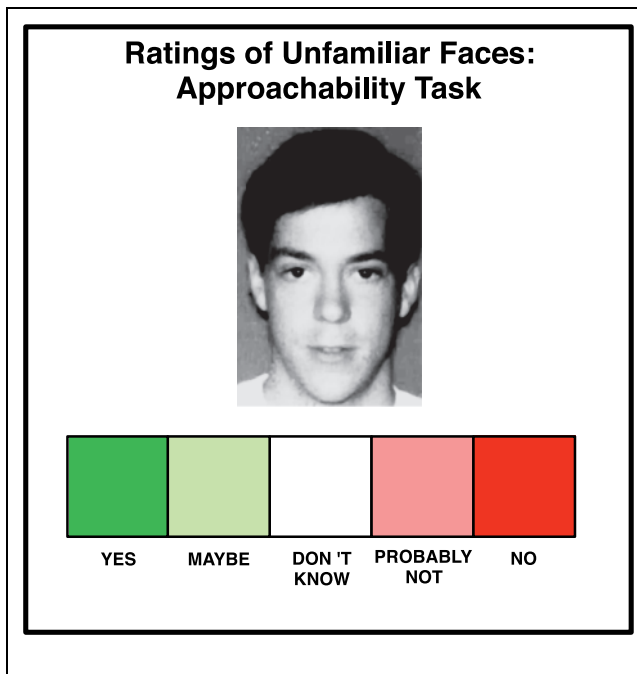


Figure 8. For the Adolphs' Approachability Rating task, each subject is asked to rate the extent to which they would like to go up and talk to (approach) an unfamiliar person pictured. They rate their responses on a five-point, color-coded scale from "definitely yes" to "definitely no."

that WMS subjects differed significantly from both same age normal controls ($p < .01$) and from mental age controls ($p < .0005$) in giving abnormally positive ratings overall. Post hoc tests of the interaction between subject group and stimulus valence showed that subjects with WMS rated the 21 most negative faces significantly more positively than either same age normal controls (mean rating difference = .44; $p < .001$) or mental age controls (mean rating difference = .43, $p < .001$). The subjects with WMS also rated the 21 most positive faces more positively than either normal controls (mean rating difference = .46; $p < .001$) or mental age controls (mean rating difference = 1.1; $p < .001$). Interestingly, the two control groups did not differ in their ratings of negative faces, but did differ in their ratings of positive faces (mental age controls rated those faces more negatively than normal controls; mean difference = 0.6, $p < .001$). Thus, subjects with WMS gave abnormally positive ratings of approachability to unfamiliar people, compared both to normal controls of the same age, and to normal controls of approximately the same mental age (see Figure 9). Taken together, the findings demonstrate an abnormally positive social bias in WMS.

Comments stated by subjects during the task highlight the sociability differences between the groups. For example, one WMS subject commented that a specific face "looked happy, because he's smiling," whereas a normal individual described the same face as having "a mischievous-looking smirk". These types of differences

were seen across multiple items of the task, and across subjects in the study. They suggest that individuals with WMS may rely more heavily on superficial signals that are typically viewed positively (e.g., smiling faces), but ignore more subtle social cues (e.g., furrowed eyebrows)—important issues to be addressed in future studies.

Discussion. The present findings expand and replicate the data from a prior study (Bellugi, Adolphs, Cassady, & Chiles, 1999a), and demonstrate that adolescents and adults with WMS consistently judge unfamiliar individuals as abnormally approachable, consistent with their interest in approaching strangers and engaging them in real life. To our knowledge, these studies are the first to provide a quantitative assessment of the unusual tendency to approach and engage in interactions with strangers in adolescents and adults with WMS. The findings support observations that overfriendliness, as targeted in this study, is characteristic of WMS individuals during real world social interactions. This study provides strong support for hypersociability as a phenotypic feature in individuals with WMS.

Section IV. Contrasting Social Phenotypes: WMS, DNS, and Autism

The sociability exhibited by many WMS individuals is often described by parents as pervasive and seemingly difficult to inhibit, particularly with respect to social approach behaviors to strangers. In great contrast, individuals with autism are typically asocial and tend not to interact with others, whether strangers or not. Thus, individuals with WMS and those with autism represent two polar opposite groups in terms of social behavior. Individuals with DNS have been characterized as friendly, but the similarities and differences between these three groups have not been investigated to date. We designed a study to investigate social behavior in these three contrasting groups.

For this study, an experimental sociability questionnaire was developed to better characterize the limits of the social nature seen in individuals with WMS (Chiles, Bellugi, & Cassady, 1998). On the questionnaire, parents were asked to rate their child's specific social abilities and tendencies. Items assessed the tendency to approach others, general behavior in social situations, ability to remember names and faces, eagerness to please other people, tendency to empathize with or comment on others' emotional states, and the tendency for other people to approach the child. The questionnaire was administered to same-aged subjects with WMS, DNS, and normal controls. In addition, the questionnaire was also administered to same-aged subjects with stringently diagnosed autism (see above), as part of a study in progress. Subjects with autism

High Approachability Bias in Individuals with Williams Syndrome

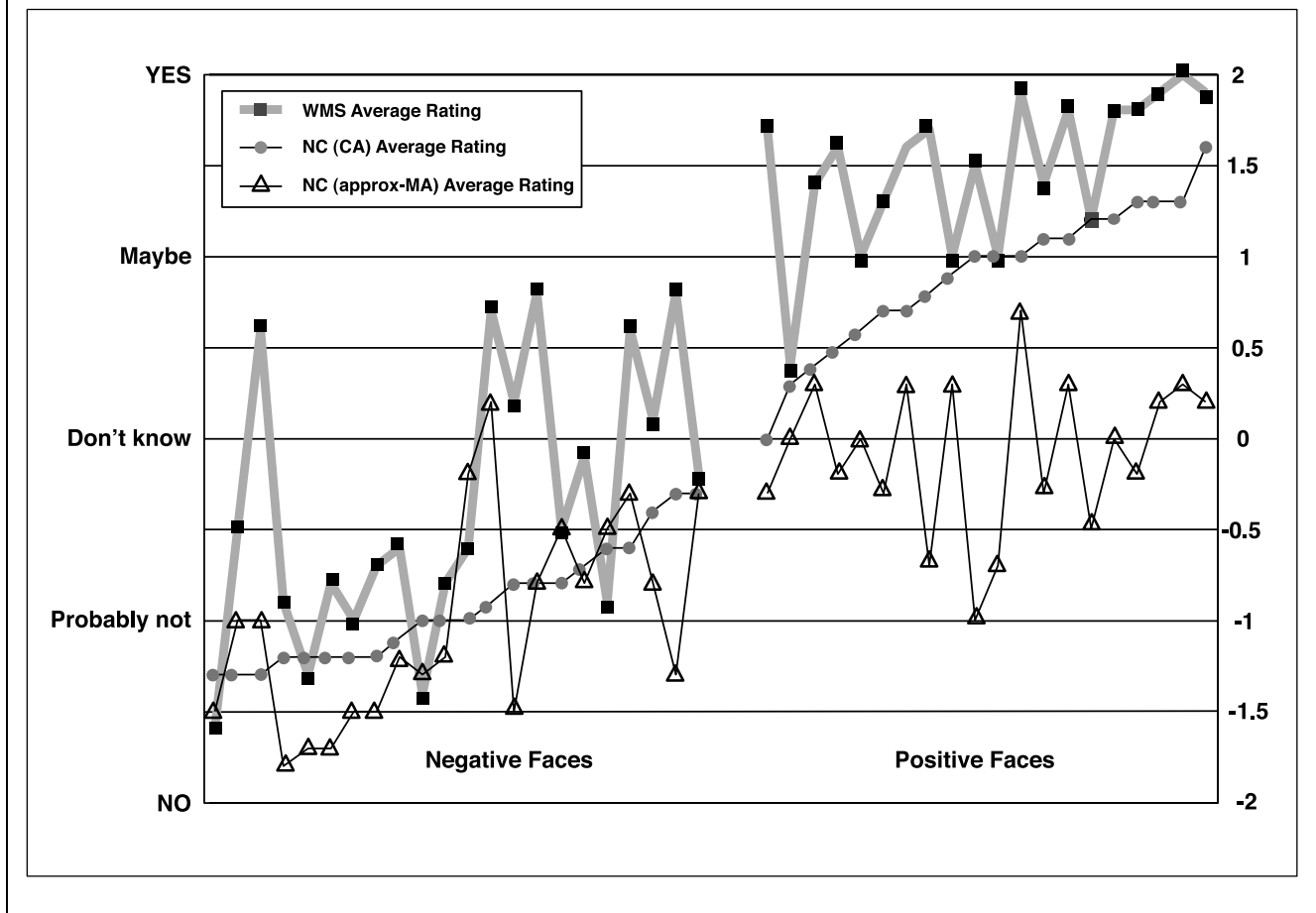


Figure 9. In the experimental task, adolescents with WMS consistently rate themselves as more likely to approach and engage unfamiliar individuals than do chronological age-matched normal controls or mental age-matched controls (younger children). NC (CA) = normal controls (chronological age-matched); NC (approx-MA) = normal controls (approximately mental age-matched); WMS = Williams Syndrome subjects.

provide a striking contrast to WMS in terms of social behavior.

Subjects. The Salk Institute Sociability Questionnaire was sent to 20 parents of individuals with WMS (mean age = 18.9 years; SD = 10.7), 20 parents of individuals with autism (mean age = 17.9 years; SD = 7.1), 20 parents of individuals with DNS (mean age = 18.9 years; SD = 13.0), as well as 15 parents of typically developing children (mean age = 17.0 years; SD = 10.7). Results from ANOVA with age by syndrome revealed that the groups in the study were well matched on age ($n.s.$, $p > .05$).

Procedures. The Salk Institute Sociability Questionnaire was developed as an index of the many aspects of sociability seen in people with WMS (Chiles et al., 1998). The questionnaire is a parental-report rating scale in which parents are asked to rate their child's specific social abilities and tendencies on a seven-point Likert scale with low-, mid-, and high-endpoint

labels tailored to each individual item. Questionnaire items were designed to measure two aspects of sociability: Social approach behavior and social emotional behavior. The items that measure social approach behavior consist of statements such as "Compare your child's tendency to approach strangers with an average child of the same age," and "Compare a stranger's tendency to engage your child with an average child of the same age." Other questionnaire items were designed to assess their social-emotional behavior. These items measure their tendency to empathize with or comment on other people's emotional state, as well as the accuracy of their emotional evaluation of others and their eagerness to please other people. In addition, parents are also asked to provide qualitative descriptions of their child in various social situations.

Three composite scores were developed on the basis of the original questionnaire items: (A) The Global Sociability score combines the scores of all items on the questionnaire and is designed as a cross-domain mea-

sure of Sociability; (B) the Social Approach score combines only the scores of items related to the subject's approach behavior toward other people (e.g., tendency to approach strangers); and (C) the Social Emotional score is composed of the items querying social behaviors, such as the accuracy of their emotional evaluation of others. ANOVA were used for all comparisons, with group as a factor, and each composite score as a dependent measure.

Results. Qualitative examples from the questionnaire items highlight the differences between the WMS, Autism and DNS groups. For example, when asked to give an example of their children socializing with strangers, the parent of an Autistic adolescent said, “[He] requires a prompt to say hello. [He] avoids people whenever possible.” The parent of a same-age DNS adolescent said, “[He is] somewhat quiet and shy unless he feels comfortable.” In contrast, the parent of an adolescent with WMS reported, “[He] is very happy to meet people. [He] asks many questions about them, their family, pets, language, nationality and number of children.” See Figure 10 for additional examples.

ANOVA with group (WMS, DNS, autism and normal control) by Global Sociability score revealed significant differences between the groups on this measure ($F(3,59) = 31.11, p < .0001$). Post hoc follow-up

comparisons revealed that subjects with WMS were rated as being significantly more social than were the DNS, autistic or normal control subjects (all comparisons $p < .001$), while autistic subjects were rated least social relative to the other groups ($p < .001$). DNS subjects and normal controls were rated comparably by their parents ($p > .20$) and had mean scores between the WMS and autistic groups (see Figure 11a). Examples of parental comments characterize the typical differences among the groups.

Breaking down the general sociability findings, specific subcategories of differences were also found. A significant difference between the groups was detected for the Social-Emotional subscale ($F(3,60) = 31.08, p < .0001$). Follow up comparisons revealed that the WMS group was consistently rated higher than the autistic group on this scale as well and, indeed, scored the highest of all the reference groups on the Social-Emotional subscale (all comparisons significant, $p < .01$; see Figure 11b). In addition, the autistic group was consistently rated lower than the other groups (all comparisons significant, $p < .0001$), while the DNS and normal control groups were rated similarly by their parents (n.s., $p > .05$).

Significant differences among the groups were also found for a scale measuring Social Approach behaviors ($F(3,65) = 30.06, p < .0001$). Subjects with WMS were

Figure 10. Parents of adolescents and adults with WMS report unusual interest and predilection for approaching others. Typical qualitative examples are shown from each group. The social behavior reported for WMS was in stark contrast to that reported for Autism, and characteristically different (hypersocial) from that reported for DNS and for typically developing normal individuals in the same-age range. DNS = Down Syndrome subjects; WMS = Williams Syndrome subjects.

<p>The Sociability Questionnaire for Williams Syndrome, Down Syndrome, and Autism</p> <p>"Give some examples of your teenager socializing with strangers:"</p>		
WMS	Autistic	DNS
He will go right up to a stranger, get eye contact, and say "hi" again and again until that person says "hi" back.	All people are treated the same-- avoid whenever possible. She will isolate herself and engage in repetitive rituals. She recognizes people but prefers to be alone.	Shy, averts eyes, avoids person, physically withdrawn unless person can communicate with him, then he is engaged easily.
"Hi, my name is B, what is your name?" or "It's nice to meet you, do you own a car wash?" He would always approach the person, introduce himself, and then ask questions.	No speech, head down, very shy and unapproachable.	Mother usually has to initiate and encourage, and then sometimes he will socialize.
Very happy to meet them. Asks many questions about them, their family, pets, language, nationality and number of children.	Requires prompt to say hello. Avoids people whenever possible.	Somewhat quiet and shy, unless he feels comfortable.
"Oh it's so nice to meet you. Where are you from? Are you married? I have a dog, do you have a dog? Oh really?!!! I have a friend who has a broken arm, bad back, new baby, a cat...etc."	Does not socialize with strangers.	Can be shy but appropriate, says "hello."

Quantitative Measures of Sociability Contrasting Williams Syndrome, Down Syndrome, and Autism

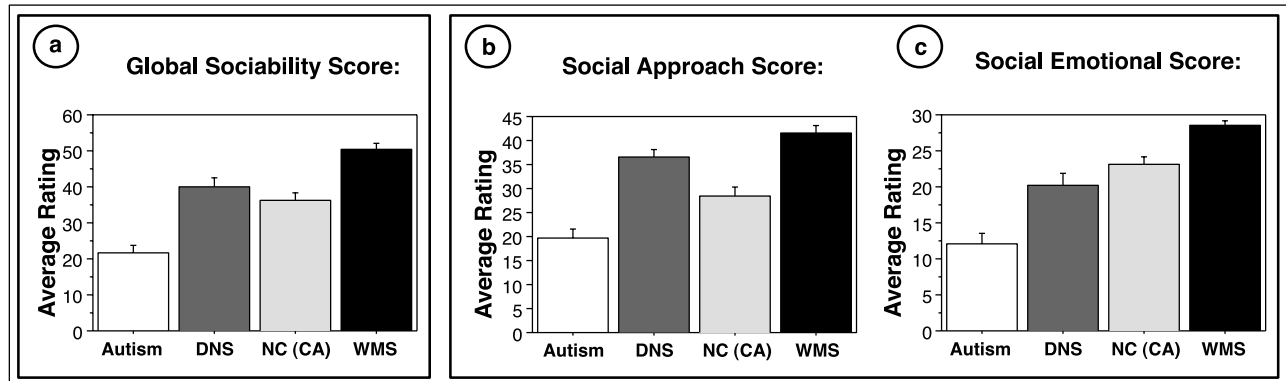


Figure 11. Individuals with WMS are consistently rated as more social than individuals with Autism, DNS, or normal controls matched for chronological age on several parental report scales of social behavior, including Global Sociability behaviors as well as Social Approach and Social Emotional items. NC (CA) = normal controls (chronological age); WMS = Williams Syndrome subjects; DNS = Down Syndrome subjects.

rated most highly in their interest in approaching others (all comparisons significant, $p < .05$), while subjects with autism were rated the lowest (all comparisons significant, $p < .01$). Subjects with DNS were rated more highly than normal controls and subjects with autism, but were rated lower than subjects with WMS (all comparisons significant, $p < .05$); while normal controls were rated significantly higher than subjects with autism, but were lower than the WMS and DNS groups (all comparisons significant, $p < .05$).

Discussion. The findings from this study support previous results related to a social profile in WMS. The profile appears to consist of an excessive interest in others and a lack of inhibition toward approaching other individuals. As expected, subjects with autism are judged to have significant social deficits and appear uninterested in approaching others. Normal control and DNS subjects are social but not overly so, while WMS subjects are generally overly social and exhibit a tendency to hypersociability. The findings suggest that WMS behavior within the domain of sociability may be distinct from that seen in other disorders. Such findings provide the framework for investigating the neurobiological basis of social behavior.

The findings from the study also demonstrate specific differences in sociability between individuals with WMS and those with other disorders, notably those with autism. Indeed, social behavioral contrasts between WMS and autism are striking (Courchesne, Bellugi, & Singer, 1995). WMS children seek out social interaction and eye contact and, generally, do it in a polite and friendly manner. Galaburda, Wang, Bellugi, and Rossen (1994) write in a description of a WMS child, “He drew people to him as though he had a (social) magnet in

him.” In contrast, the cardinal feature of autism is a profound deficiency in social knowledge, affective expression, and communication. The autistic child avoids eye contact and is poor at discriminating facial expressions. In an early description of an autistic child, Kanner (1943) wrote, “He paid no attention to persons around him...he completely disregarded the people (in a room) and instantly went for an object...he was happiest when left alone.” Future studies examining the neuroanatomical differences between WMS and Autism may reveal clues to aspects of the neural and genetic bases of social behavior.

DISCUSSION

The studies reported in this paper show that hypersociability is a salient aspect of behavior in WMS. The WMS social nature consists of a strong drive toward social interaction with other people. As Section I shows, the social drive appears to influence other cognitive domains, including language, and evidence of it can be detected even in simple narrative and storytelling tasks. Section II suggests that it is developmentally pervasive, as evidence of it is detected in children even before they are able to talk. Sections III and IV suggest that it is quantifiable through both objective tasks, such as those measuring subjective interest in approaching other people, as well as through parental report. Finally, Section IV reveals that the hypersocial drive of subjects with WMS appears to strongly distinguish WMS from other disorders, including autism and DNS, as well as from normally developing peers. Taken together, the studies presented here suggest that the social behavior of subjects with WMS is quantifiable and, indeed, highly unusual relative to other disorders. The findings now prepare future

studies linking this aspect of the WMS phenotype to other domains, including genetics and neuroanatomy.

Current studies of brain morphology in WMS are progressing rapidly and are likely to lead to the neurobiological underpinnings of the behaviors described in this study (see, for instance, Galaburda & Bellugi, this volume; Reiss et al., this volume; Jernigan, Bellugi, Sowell, Doherty, & Hesselink, 1993). The amygdala, for instance, has been found to play a role in social behavior and may be a likely neurological substrate for some of the behaviors described in WMS. Like patients with focal bilateral damage to the amygdala (Adolphs et al., 1998), individuals with WMS give abnormally positive ratings to unfamiliar people, appear unusually friendly, and tend to approach others somewhat indiscriminately in real life. However, there are also notable differences between the performances given by subjects with WMS and those previously reported for subjects with bilateral amygdala damage. Importantly, subjects with WMS gave abnormally positive ratings across all faces. Subjects with amygdala damage, in contrast, were found to give more positive ratings only for faces that typically received the most negative ratings from controls (Adolphs et al., 1998). Taken together, the findings may suggest links between aspects of abnormal social behavior in WMS, and possible dysfunction in the amygdala and other limbic regions.

The WMS social profile also provides an opportunity for scientists to hypothesize about new brain areas underlying aspects of social behavior. It was not until recently, for example, that the role of the cerebellum was expanded from motor behavior to also encompass aspects of higher cognition. Studies now suggest, for example, that the cerebellum may play a role in regulating affective expression across various disorders (Schmahmann, 1997; Schmahmann & Sherman, 1998). Neuroanatomical contrasts between subjects with WMS and Autism suggest that areas of the cerebellum may play a role in the sociability differences between these two disorders. Whereas the neocerebellar vermis appears to be disproportionately enlarged in individuals with WMS (Jones et al., 1999b; Wang, Hesselink, Jernigan, Doherty, & Bellugi, 1992), it appears disproportionately small in individuals with autism and may be one important substrate of the social deficiencies in the disorder (Courchesne et al., 1994a; Courchesne, Townsend, & Saitoh, 1994b). Such contrasts between WMS and other disorders are likely to lead to better delineation of the neurological bases of social behavior.

The work described in this paper highlights a new aspect of the WMS phenotype. Taken in combination with other behaviors in the syndrome, the phenotype is providing the pathway for linking specific genes to specific behaviors, as well as to the specific brain areas underlying these behaviors. By adding a new dimension to the previously described phenotype in WMS, the studies described here provide a more specific behavior-

al profile to better guide studies of the anatomic and genetic underpinnings of WMS. We pursue the study of social behavior in WMS with the aim of linking findings to brain morphology and, ultimately, to the gene.

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